

# [EP07.20] Optimizing tractography parameters for fetal brain connectomics: a comparative analysis of six configurations

R Corroenne<sup>1</sup>, D Grevent<sup>2</sup>, L Salomon<sup>1,3</sup>

1. EA fetus 7328 and LUMIERE Platform, University of Paris, Paris, France; 2. Department of Radiology, Necker-Enfants Malades Hospital, APHP, Paris, France

3. Department of Obstetrics, Fetal Medicine and Surgery, Necker-Enfants Malades Hospital, APHP, Paris, France

## Objective

To determine the most appropriate tractography configuration for assessing fetal brain connectivity by comparing six parameter sets derived from postnatal studies and physiological hypotheses.

## Methods

Retrospective study of fetuses with normal brain anatomy between 22 and 36 weeks at the Hôpital Necker–Enfants Malades (LUMIERE on the FETUS – NCT04142606).

Whole-brain tractography was performed using six configurations derived from postnatal studies and physiological hypotheses adapted to fetal development (Table 1).

A 125-region brain parcellation atlas was applied to generate connectivity matrices.



Gholipour et al.

| Table 1         | Angle Thresh old | Step Size | Streamline Lengths | Algorithm Type | Description                                                            |
|-----------------|------------------|-----------|--------------------|----------------|------------------------------------------------------------------------|
| Configuration 1 | 45°              | 0.5 mm    | 20 - 200 mm        | Probabilistic  | Balanced configuration with moderate curvature and length constraints. |
| Configuration 2 | 30°              | 0.5 mm    | 20 - 200 mm        | Probabilistic  | Higher angular resolution for detecting sharp turns in fibers.         |
| Configuration 3 | 60°              | 0.5 mm    | 20 - 200 mm        | Probabilistic  | Allows wider curvature, suitable for longer tracts.                    |
| Configuration 4 | 45°              | 1.0 mm    | 20 - 200 mm        | Deterministic  | Balanced deterministic approach with moderate smoothness.              |
| Configuration 5 | 45°              | 0.5 mm    | 20 - 200 mm        | Deterministic  | Higher spatial resolution with finer step size.                        |
| Configuration 6 | 45°              | 1.0 mm    | 50 - 200 mm        | Deterministic  | Reduced noise by setting a higher minimum length threshold.            |

Connectivity patterns were compared using visual assessment on heatmaps, MANOVA, and meta-analyses of inter-configuration correlations and mean differences.

## Results

10 fetuses were included at 30[22-36] weeks of gestation.

MANOVA revealed significant difference in global brain connectivity between configurations ( $p<0.01$ ).

Visual comparison of the connectivity matrices obtained with 6 different configuration in the same fetus at 32 weeks revealed significant visual difference (Figure 1).

**Configuration 4** demonstrated the highest reproducibility, with a weighted correlation coefficient of 0.66 and minimal heterogeneity across subjects ( $I^2 = 8.1\%$ ).

Configuration 3 showed the greatest variability (lowest correlation, highest  $I^2$ ).

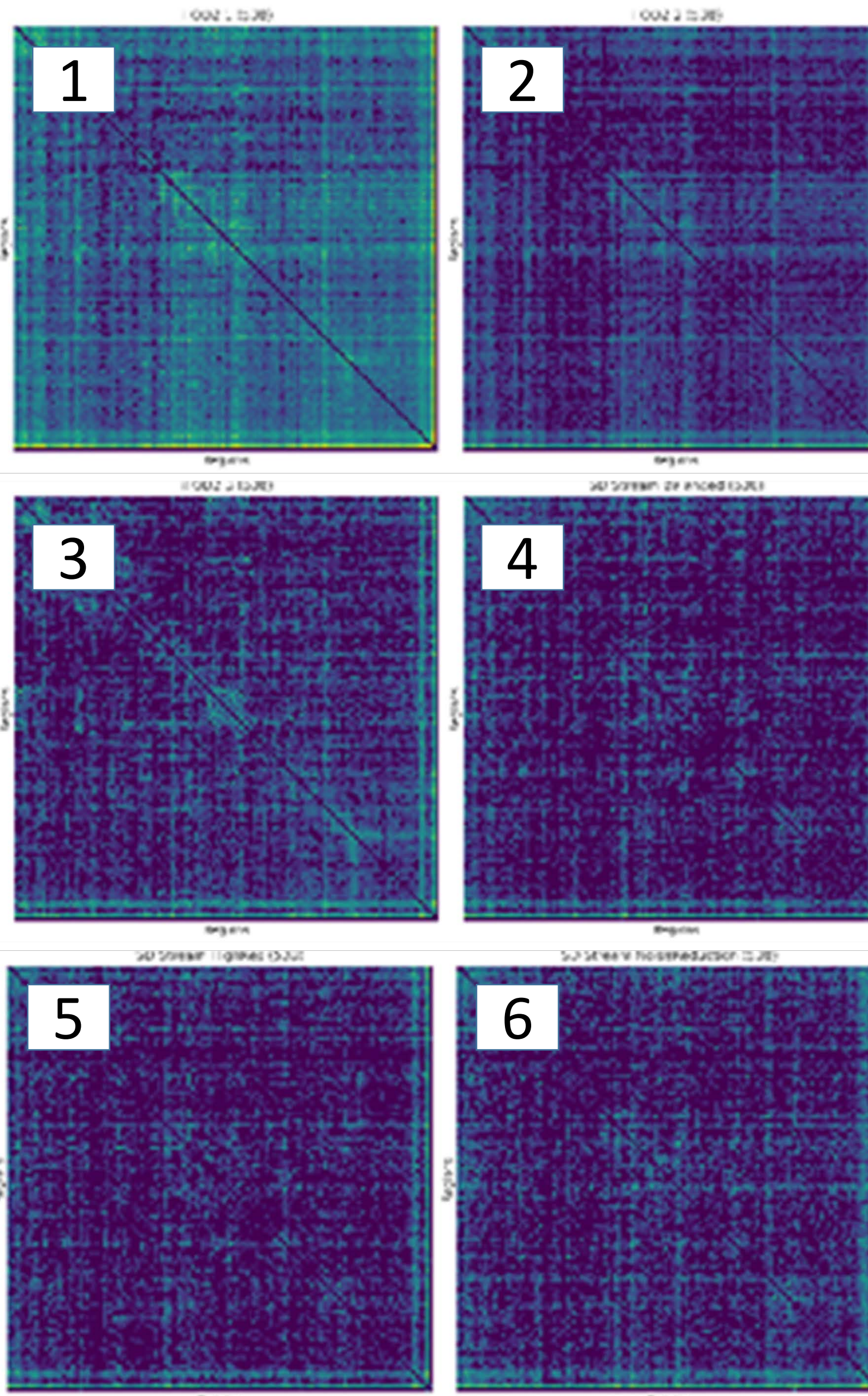


Fig 1. Visual comparison of connectivity matrices obtained in the same fetus at 32 weeks

## Conclusion

Among the tested approaches, Configuration 4 provided the most stable and consistent connectivity patterns across gestation, supporting its use as a reference for fetal connectomics research.